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Comparison of the efficacy of transcutaneous electrical stimulation and interference current in patients with gonarthrosis

Ayşe Gülşen Doğan

Hitit University Erol Olçok Training and Research Hospital, Department of Physical Medicine and Rehabilitation, Çorum, Turkey

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ABSTRACT

Aim: In this study, it was aimed to evaluate the effects of transcutaneous electrical stimulation (TENS) and interference current (IFC) modalities on pain, function and quality of life in the treatment of patients with gonarthrosis.

Material and Method: The aim of this study is to evaluate the effects of TENS and IFC modalities on pain, function and quality of life in the treatment of patients with gonarthrosis and to compare them in terms of their superiority.

Results: 80 patients were included in the study. In the TENS and IFC groups, the degree of active-passive knee flexion and extension increased significantly on the 15th day of treatment (T15th day) and at the 3rd month after treatment (AT 3rd month), while it was at a similar level between the 15th day and the 3rd month of treatment. In the comparison of the 15th day of the treatment and the 3rd month after the treatment, the increase in the active-passive flexion and extension measurements in the IFC group was found to be statistically significant (flexion T15th day p=0.007 AT 3rd month p=0.000, extansion T15th day p=0.004 AT 3rd month p=0.031). The decrease in WOMAC total value at the 15th day of the treatment and at the 3rd month after the treatment was found to be significantly decreased in the IFC group (T15th day p=0.013, AT 3rd month p=0.000).

Conclusion: IFC both increased the range of motion of the knee joint in patients with gonarthrosis and contributed to the functional recovery in knee osteoarthritis.

Keywords: Gonarthrosis, TENS, interference current

INTRODUCTION

Osteoarthritis is the most common disease of joints in adults around the world (1). Felson et al. (2) reported that about one-third of all adults have radiological signs of osteoarthritis, although Andrianakos et al. (3), in an epidemiological study, found clinically significant osteoarthritis of the knee, hand, or hip in only 8.9% of the adult population. Gonarthrosis was the most common type (6% of all adults) . Treatment of gonarthrosis can be divided into non-surgical or surgical treatment. Non-surgical treatment comprises non-pharmacological and pharmacological treatment and non-pharmacological treatment comprises core first-line treatment for all patients with OA, including education, self-management, exercise and weight reduction. Other primary non-pharmacological treatments for gonarthrosis include walking canes and biomechanical interventions like braces and orthosis. Pharmacological therapy may include the use of paracetamol, topical or oral non-steroidal anti-inflammatory drugs (NSAIDs), or intra-articular corticosteroids. Surgical procedures are a last resort for end-stage gonarthrosis, the most effective type of which is total knee arthroplasty with rehabilitation (4). Commonly used treatment modalities are insoles, lasers, transcutaneous electrical nerve stimulation, ultrasound, electrotherapy, or acupuncture, but evidence is scarce, as is the effect size. However, applications of heat and ice are easy to use and quite effective (5). Electrical stimulation is a non-invasive treatment option that has been preferred since ancient times, in which the stimulus is applied superficially to the desired area with electrodes placed on the skin. Electrotherapy methods such as transcutaneous electrical stimulation (TENS), neuromuscular electrical stimulation (NMES), interference current (IFC), pulsed electrical stimulation (PES), non-invasive interactive neurostimulation (NIN) have previously been preferred

Corresponding Author: Ayşe Gülşen Doğan, drmdagu@gmail.com

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and reported to be effective in the treatment of knee OA. However, there is not enough evidence about the superiority of these treatment methods over each other in the treatment of knee OA (6-8). There is very little evidence comparing the effects of modalities such as IFC or TENS in the treatment of knee OA, indicating which method should be preferred. Therfore, in our study, we aimed to evaluate the effect of TENS and IFC modalities on pain, function and quality of life in the treatment of gonarthrosis patients.

MATERIAL AND METHOD

The study was carried out with the permission of Hitit University Medical Faculty Clinical Researches Ethics Committee (Date: 11.05.2022, Decision No: 423). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The study was conducted on 80 patients with bilateral gonarthrosis who applied to the Physical Medicine and Rehabilitation outpatient clinic of our hospital. Inclusion criteria included being between the ages of 40-75, being diagnosed with gonarthrosis according to the diagnostic criteria of the American College of Rheumatology and having bilateral stage 2-3 gonarthrosis according to the Kellgren Lawrence classification. Pregnancy, malignancy, pacemaker, cardiac arrhythmia, autoinflammatory disease, active infection and neuromuscular disease history were determined as exclusion criteria. Patients were randomized into two groups using the sealed envelope method. Forty patients in the first group were given 20 minutes (min) of hotpack, 20 minutes of conventional TENS (stimulation frequency 80 Hz, phase duration 200 ms, current density between 10-50 mA), 8 minutes of shortwave diathermy and 15 minutes of home program isometric quadriceps strengthening exercise. Forty patients in the second group were given 20 minutes of hotpack, 20 minutes of IFC (carrier frequency 4.0 kHz, pulse frequency 100 Hz), 8 minutes of shortwave diathermy and 15 minutes of home program isometric quadriceps strengthening exercise therapy.

Functional Assessment

Western OntarioMacMaster (WOMAC): WOMAC is a 24-item scale used to evaluate pain and function especially in hip and knee osteoarthritis. Each question is evaluated on a 5-point Likert scale. It has three subscales: pain, physical function and stiffness. The pain subscale is evaluated with five items. Therefore, it is scored between 0-20. The function subscale has 17 items, scored from 0 to 68. The hardness subscale has two items and is scored from 0 to 8. High scores indicate poor function, pain or stiffness (9).

Measurement of knee joint range of motion: All measurements in the treatment groups were evaluated by the FTR specialist before the treatment, on the 15th day of the treatment and at the 3rd month after the treatment. Knee flexion and extension of the patients were measured both actively and passively by goniometry.

Evaluation of Quality of Life

Short form-36 (SF-36): The quality of life was assessed using the validated Turkish version of the 36-item Short-Form Health Survey (SF-36). The SF-36 is a multidimensional tool measuring eight domains: physical functioning, physical role limitation, body pain, general health, vitality, social functioning, emotional role limitation and mental health. Domain scores range from 0 to 100 and higher scores indicate a better quality of life (10).

Statistical Analysis

Statistical analyzes were performed using SPSS version 20 package software. Descriptive statistics are summarized as numbers, percentages, mean and standard deviation. The conformity of the variables to the normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Kolmogorov – Smirnov, Shapiro-Wilk tests). The numerical variables determined according to the normal distribution were compared between the two groups using the t test in independent and dependent groups. Numerical variables that did not show normal distribution were compared between the two groups using Mann Whitney U test and Wilcoxon test. Values with a p value of <0.05 were considered as statistically significant results.

RESULTS

Of the 40 patients with gonarthrosis in the first group, 57.5% were female (23), 42.5% were male (17). Of the 40 patients in the second group, 52.5% were female (21), 47.5% were male (19). There was no statistical difference between the groups in terms of gender distribution ($p=0.623$). While the mean age of the patients was 57.8±5.2 years in the TENS group, it was 55.8±7.5 years in the IFC group and there was no statistical difference between the two groups ($p=0.265$). The mean body mass index (BMI) was 31.9±6.2 kg/m^2 in the TENS group and 33±7.1 kg/m^2 in the IFC group. There was no statistically significant difference between the two groups ($p=0.173$). The mean pain duration of the patients was found to be 21 months in the TENS group and 25 months in the IFC group and no significant difference was found between the groups ($p=0.453$) (**Table 1**). In the TENS and IFC groups, the degree of active-passive knee flexion and

extension increased significantly on the 15th day of treatment and at the 3rd month after treatment , while it was at a similar level between the 15th day and the 3rd month of treatment (**Table 2**). There was no significant difference in knee range of motion measurements of TENS and IFC groups before treatment. In the comparison of the 15th day of the treatment and the 3rd month after the treatment, the increase in the active-passive flexion and extension measurements in the IFC group was found to be statistically significant (**Table 3**). There was no significant difference between the TENS and IFC groups in terms of WOMAC pain, stiffness and function sub-scores before treatment, on the 15th day of treatment and at the 3rd month after treatment. The decrease in WOMAC total value at the 15th day of the treatment and at the 3rd month after the treatment was found to be significantly decreased in the IFC group (TS p=0.013, TS 3rd month p=0.000) (**Table 4**). In the evaluations of the patients before the treatment, on the 15th day and at the 3rd month of the treatment, the quality of life parameters measured by the SF-36 questionnaire were compared between the two groups. There was no significant difference between the two groups in terms of physical function, social function, physical role difficulty, emotional role difficulty, mental health, energy/vitality, body pain and general health scores (**Table 5**).

Table 1. Demographic and clinical characteristics of the treatment groups

	TENS(n=40)	IFC(n=40)	p value
Age (Mean±SD)	57.8±5.2	55.8±7.5	0.265*
Female M/K	17/23	19/21	0.623**
BMI (Mean±SD)	31.9±6.2	33.±7.1	0.173*
Knee pain duration (months)	21 m	25 m	0.256***
K/L scale n(%)	Grade 2: 16 (40) Grade 3: 24 (60)	Grade 2:14 (35) Grade 3:26 (65)	0.453**

*T test in independent groups **Chi-square test ***Mann Whitney U test K/L: Kellgren Lawrence, SD standard deviation

Table 2. Comparison of active-passive flexion and extension values of TENS and IFC groups in three stages

	Before treatment (BT)	15th day of treatment (T15th day)	3rd month after treatment (AT 3rd month)	p (BT-T15th day)	p (T15th day -AT 3rd month)	p (AT 3rd month-BT)
TENS						
Active flexion	109±10.9	116±11.4	117±11	0.043	0.641	0.013
Passive flexion	119±9.9	121±7.6	122±8.4	0.036	0.763	0.021
Active extension*	-2.1±2.8	-1.9±2.6	-1.8±2.5	0.035	0.368	0.041
Passive extension*	-1.9±2.3	-1.4±2.1	-1.3±2.4	0.023	0.296	0.001
IFC						
Active flexion	111±9.9	121±8.9	122±9.7	0.017	0.051	0.021
Passive flexion	121±7.4	126±8.1	127±8.3	0.041	0.078	0.034
Active extension*	-2.4±2.9	-1.7±2.7	-1.6±2.5	0.029	0.596	0.012
Passive extension*	-1.7±2.3	-1.3±2.1	-1.3±2	0.013	0.631	0.024

*Wilcoxon test

Table 3. Comparison of the active-passive flexion and extension values of the patients before the treatment, at the 15th day of the treatment and at the 3rd month of the treatment.

	TENS Mean±SD	IFC Mean±SD	p value
Active flexion			
Before treatment	109±10.9	111±9.9	0.262
15th day of treatment	116±11.4	121±8.9	0.007
3rd month after treatment	117±11	122±9.7	0.000
Passive flexion			
Before treatment	119±9.9	121±7.4	0.065
15th day of treatment	121±7.6	126±8.1	0.011
3rd month after treatment	122±8.4	127±8.3	0.001
Active extension			
Before treatment	-2.1±2.8	-2.4±2.9	0.247
15th day of treatment	-1.9±2.6	-1.7±2.7	0.004
3rd month after treatment	-1.8±2.5	-1.6±2.5	0.031
Passive extension			
Before treatment	-1.9±2.3	-1.7±2.3	0.146
15th day of treatment	-1.4±2.1	-1.3±2.1	0.008
3rd month after treatment	-1.3±2.4	-1.3±2	0.041

Table 4. Comparison of WOMAC scores between groups

	TENS	IFC	p value
WOMAC-total			
Before treatment	50.2±19.2	51.7±21.3	0.071
15th day of treatment	36.4±18.7	32.4±20.9	0.013
3rd month after treatment	37.5±19.4	31.9±21.1	0.000
WOMAC-pain			
Before treatment	9.8±3.8	10.2±4.8	0.892
15th day of treatment	8.2±3.5	7.9±4.2	0.774
3rd month after treatment	7.2±3.6	7.6±4.3	0.813
WOMAC- stiffness			
Before treatment	3.4±2.1	3.7±2.2	0.059
15th day of treatment	3.1±2.3	3.4±2.1	0.771
3rd month after treatment	3.2±2.4	3.6±2.1	0.823
WOMAC-function			
Before treatment	34.6±14.9	36.1±15.2	0.278
15th day of treatment	29.4±14.4	30.1±15.3	0.417
3rd month after treatment	27.6±14.6	31.6±15.7	0.315

Table 5. Comparison of the patients' quality of life (SF-36) scores before the treatment, at the 15th day and at the 3rd month of the treatment between the groups

	Before treatment			15th day of treatment			3rd month after treatment		
	TENS Mean±SD	IFC Mean±SD	p value	TENS Mean±SD	IFC Mean±SD	p value	TENS Mean±SD	IFC Mean±SD	p value
PF	47.47±17.28	48.76±19.33	0.908	48.49±18.24	49.71±20.31	0.901	64.12±25.08	62.57±19.50	0.781
RP	11.50±20.53	18.55±25.99	0.336	12.55±21.51	18.50±26.50	0.335	46.31±42.50	50.98±36.35	0.763
BP	36.37±16.21	37.44±17.82	0.390	36.25±16.42	39.44±19.82	0.394	56.85±23.30	60.71±21.15	0.625
GH	48.83±24.01	44.55±18.57	0.568	48.81±23.84	45.54±19.00	0.567	51.56±19.30	48.79±20.32	0.883
V	50.10±21.03	50.09±22.37	0.971	51.20±20.39	51.24±22.35	0.871	57.70±21.19	55.56±24.40	0.696
SF	54.55±19.22	61.00±16.00	0.055	54.55±19.22	62.90±15.30	0.061	68.38±20.80	65.73±19.10	0.549
RE	38.76±38.86	37.52±38.01	0.590	39.01±29.23	33.44±37.51	0.573	55.53±38.11	45.60±37.12	0.335
MH	57.34±19.04	53.46±19.40	0.653	57.44±18.50	54.45±19.40	0.645	63.71±19.80	60.70±20.73	0.461

PF: physical functioning, RP:role limitations due to physical problems, BP: bodily pain, GH: general health perceptions, V:Vitalite, SF: social functioning, RE: role limitations due to emotional problems, MH: Mental health

DISCUSSION

Osteoarthritis (OA) is one of the most prevalent degenerative musculoskeletal diseases. This disease is affecting almost 5% of the global population (11). The knee is the most common joint affected by OA, which is characterized by irreversible degeneration of the articular cartilage at the ends of the bones such as femoral, tibial and patella cartilages. Knee osteoarthritis (knee OA) is a progressive disease that affects the entire knee joint. Knee OA is a condition driven by mechanical wear and tear as well as biochemical changes. Known risk factors for OA include aging, obesity and previous knee injuries (12). In our study in patients diagnosed with gonarthrosis with an increased number of women, BMI and mean age, it was observed that knee flexion, extension and WOMAC scores improved with both TENS and IFC treatments. Most of these improvements were sustained up to the third month after treatment. Our findings were primarily that both treatments were effective in patients with gonarthrosis. However, when TENS and IFC were compared, there were differences in knee flexion, extension and total WOMAC scores in the IFC group at the 15th day and 3rd month of the treatment. Our study, which indicates the efficacy of IFC in the treatment of gonarthrosis, provided evidence-based data on IFC. In the literature, there are studies that present similar and opposite views about IFC. Gundog et al. study showed that IFC treatments were effective interventions for the management of knee OA, with some advantages in pain and disability outcomes over the sham IFC. However, they could not find that different frequencies of the amplitude-modulated wave of IFC influenced the results, supporting various IFC frequencies that can be used for pain relief (7). Buenavente et al. (13) performed a meta-analysis to evaluate the effectiveness of IFC on knee osteoarthritis. Four studies were included for meta-analysis. It was concluded that IFC therapy in conjunction with therapeutic exercise is effective in decreasing pain and paracetamol intake in subjects with knee osteoarthritis. Zeng et al. (8) compared the efficacy of different electrical stimulation therapies with a control group in the pain relief of subjects with knee osteoarthritis. Twenty-seven studies were included and IFC was the only effective pain therapy when compared to controls. Thus, IFC therapy seems to be the best electrical stimulation option for pain relief in subjects with knee osteoarthritis. Adedoyin et al. evaluated the effectiveness of IFC and TENS in 46 patients with gonarthrosis, using pain and WOMAC scores. There was no significant difference in pain and WOMAC scores in the treatment groups within four weeks of treatment (14). In a study by Efterharsadat et al. (15), they compared action potential stimulation and IFC in 70 patients with gonarthrosis.The patients were evaluated with WOMAC, visual analog scales (VAS) and "Timed up and go (TUG)" and no significant difference was observed between the two groups in all parameters. In a review of non-pharmacological and non-surgical treatment methods in knee OA in 2019, it was emphasized that there are uncertainties regarding the efficacy of physical therapy modalities. Electroacupuncture, IFC, pulsed electromagnetic field, ultrasound and focal muscle vibration have been found to be effective in the treatment of patients with knee OA. It was stated that the efficacy of TENS, NMES, insoles, low-dose laser treatment could not be proven and homogeneous results could not be achieved. The modality with the most significant improvement in pain compared to the control group was found to be IFC (16). In the study of Burch et al. (17), investigated the benefits of the combination of interferential and patterned muscle stimulation in the treatment of osteoarthritis of the knee. A multi-center, randomized, single-blind, controlled study randomized 116 patients with OA of the knee to a test or control group. The test group received 15 min of IFC stimulation followed by 20 min of patterned muscle stimulation. The control group received 35 min of low-current transcutaneous electrical nerve stimulation (TENS). Both groups were treated for 8 weeks. Subjects completed questionnaires at baseline and after 2, 4 and 8 weeks. Primary outcomes included the pain and physical function subscales of the WOMAC OA Index and VAS for pain and quality

of life. Compared to the control group, the test group showed reduced pain and increased function. The test group showed a greater decrease in the WOMAC pain subscale, function subscale and stiffness subscale. More than 70% of the test group, compared to less than 50% of the control group, had at least a 20% reduction in the WOMAC pain subscale. When analyzing only patients who completed the study, the test group had a nominally significant greater decrease in overall pain VAS. Atamaz et al. (18) study aimed to compare the effectiveness of transcutaneous electrical nerve stimulation (TENS), interferential currents (IFCs) and shortwave diathermy (SWD) against each other and sham intervention with exercise training and education as a multimodal package. The study was a double-blind, randomized, controlled, multicenter trial 203 patients was inclueded. The patients were randomized by the principal center into the following 6 treatment groups: TENS sham, TENS, IFC sham, IFC, shortwave diathermy sham and shortwave diathermy. All interventions were applied 5 times a week for 3 weeks. In addition, exercises and an education program were given. They found a significant decrease in all assessment parameters, without a significant difference among the groups except WOMAC stiffness score and range of motion. However, the intake of paracetamol was significantly lower in each treatment group when compared with the sham groups at 3 months. Also, the patients in the IFC group used a lower amount of paracetamol at 6 months in comparison with the IFC sham group.

Our study had some limitations. First, the patient follow-up period in our study was limited to three months. Therefore, our findings did not include the long-term efficacy of TENS and IFC treatments. Second, patients who underwent sham IFC and IFC at different frequencies were not included in our study. By including the sham IFC group and the different IFC frequencies in the analysis, more comprehensive conclusions could be drawn about the effectiveness and frequency of IFC. Another limitation of ours is that the exercise program is performed by the patients at home and we cannot observe it by ourselves. However, exercise is an effective treatment method in increasing the range of motion and pain control in the long term.

CONCLUSION

In patients with gonarthrosis, TENS has been widely used for a long time and is among the well-known treatment options. However, there is little data on the use of IFC. In our study, we concluded that IFC both increased the range of motion of the knee joint in patients with gonarthrosis and contributed to the functional recovery in knee osteoarthritis.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Hitit University Medical Faculty Clinical Researches Ethics Committee (Date: 11.05.2022, Decision No: 423).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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